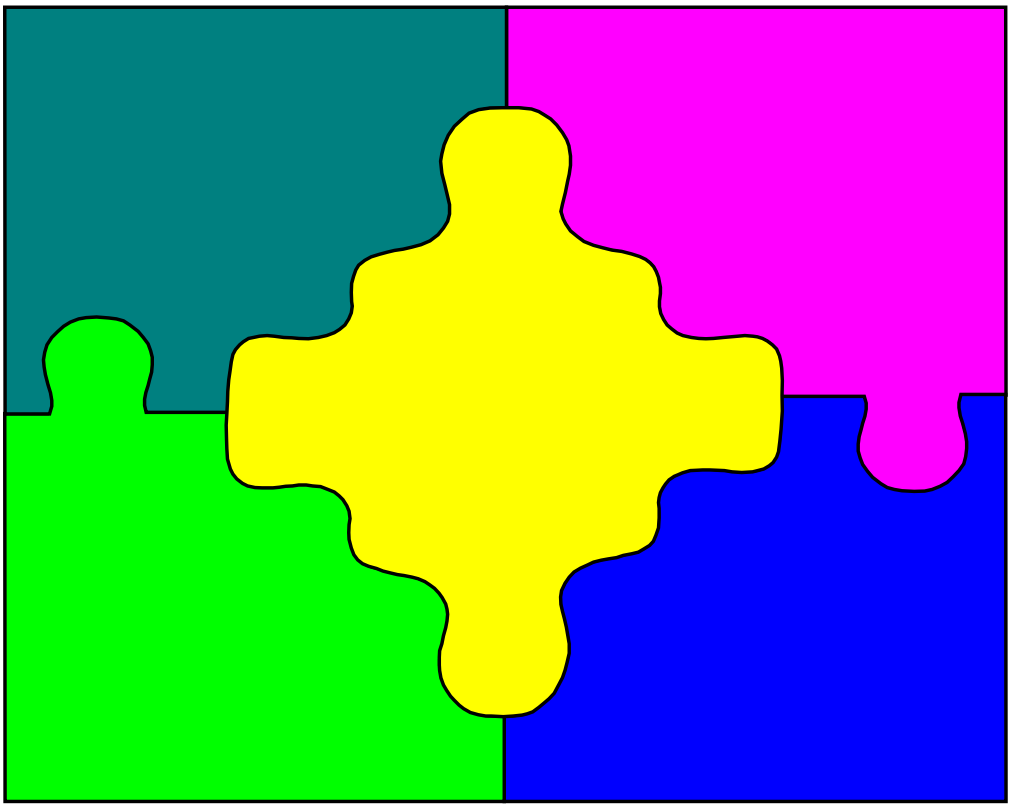
RISC Calculator

User Guide (Draft)



June 26, 2003

1 MAIN PAGE: (Sites / Projects / Calculations):

The Main Page is a filing system for all soil and groundwater sampling evaluations done by the Calculator. The site, project, and calculation are, respectively, three levels of files (sites), sub-files (projects), and sub-sub-files (calculations). Each site contains a group of projects, and each project contains a group of calculations. Each calculation can only be associated with one project, and each project can only be associated with one site.

The Main Page screens allow you to add, edit, and delete sites and projects.

A "site" is a file, but only on these site/project/calculation filing screens. The term "site" in any other soil or groundwater cleanup context, including all subsequent site evaluation discussion in this document, means the area of land being sampled and evaluated.

A "calculation" refers to a sampling area site. A calculation is a collection of all evaluations, some evaluations, or any single sampling evaluation(s) performed by the Calculator. The calculation may also include data collected over many years as well, as typically seen in groundwater closure evaluations.

> For example, for a site to reach closure of the surface soil: An area of soil is sampled at the surface, and samples are sent to a laboratory. The laboratory determines sampling results After a calculation is created on the Calculator, the results are entered into the Calculator's surface soil closure screens. The Calculator then performs the surface soil closure evaluation, and determines that the results are below safe levels.

1.1 SITES: (ADD / EDIT / DELETE)

1.1.1 Define New Site:

The first time you use the RISC Calculator, the only button available on the Main Page (aside from the ToolBar) will be the Define New Site button, located in the upper-right hand corner of the screen. Clicking on Define New Site will display the Define New Site screen, which will ask for site name and address, then will return you to this Main Page.

1.1.2 Site Name / Project:

Once sites and projects are defined, their names will appear in a Site Name / Project row, with one row for each site. For each site, the list of associated projects are shown on the drop-down box under "Projects".

1.1.1 Edit Site Information:

To edit the site name and address, find the site you want to edit in the list of rows. Press the "Edit Site" button on that row. The "Edit Site" screen will appear. Enter any corrections to the site name and address fields and press the Save button. The Main Screen will re-appear.

1.1.2 Delete Site Information:

To permanently delete a site, find the site you want to delete. Press the "Delete Site" button on that row. A warning will appear stating that you will lose information deleted. After pressing "OK", the Main Screen with re-appear with the site deleted.

- If the site contains projects or calculations, you may have to press this button a few times to clear the project and calculation sub-files.

1.1.3 Add/Edit Project:

This button is for MacIntosh users only. The button will be renamed in the future.

1.2 PROJECTS: (ADD / EDIT / DELETE)

1.2.1 Add Project:

To add a project to a site, select "Define New Project" in the drop-down field in the "Projects" column. Fill in the Project Name and EPA Facility ID# fields and press the "Save" button. The Main Screen with re-appear. The new project will be listed next to the proper site.

The EPA ID number will be renamed "project number", since this number has no format, is not unique within the office, and is defined by you (the user). Typically, you should enter the program number assigned by OLQ (eg, the LUST, RCRA, VRP program ID numbers).

1.2.2 Edit Project Information:

To edit a project, select the project to edit in the drop-down field in the "Projects" column. Make any corrections to the Project Name and EPA Facility ID# fields and press the Save button. The Main Screen will re-appear.

1.2.3 Delete Project Information:

To delete a project, select the project you want to delete in the drop-down field in the "Projects" column. To delete the project, press the "Delete Project" button. Press "OK" in the warning screen and the Main Screen will re-appear without the deleted project.

1.3 CALCULATIONS: (ADD / COPY / DELETE)

1.3.1 Adding a Calculation:

To add a calculation to a project, find the site to which you want to add the calculation. In the drop-down field in the "Projects" column, select the project to which you want to add the calculation. Press the "Define New Calculation" button. The "Define New Calculation" screen will appear. Fill in the name and type of the new calculation and press the Save button. The "Edit Project" screen will re-appear with the new calculation listed.

1.3.2 Options:

The Options button moves to a screen to copy, rename, or delete the calculation.

The copy function is similar to the “save as” function under most “File” toolbar headings. The copy option duplicates the entire calculation, including all initial screens (chemicals, residential/industrial, non-default parameters, etc.). All sampling data is copied, including boring log data, well and boring names, chemicals and concentrations assigned to corresponding borings/wells.

However, PECs and other calculation results are not copied. Results have to be re-executed within each evaluation screen.

Copying is valuable for creating “what if...” scenarios using the same data, or for adding data to an existing calculation. For instance, assume you have evaluated 3 years of groundwater monitoring data from a calculation named 3 Years. You can copy this calculation and rename it 4 Years. Then add another year of monitoring data to the same site.

1.4 MENU BAR: SEARCH (Calculation Search)

The search function, located on the orange menu bar at the top of each page, finds calculations. Just as the main page is a filing system, the search function searches for files in the system. All files created by you can be searched as well as all files that has been submitted to OLQ from any facility or consultant reporting to OLQ.

Search Screen:

On the Search screen, enter the site, project, or calculation name to display all calculations within said name. The “status” option toggles between your own “created” calculations, or “submitted” calculations to OLQ. A created calculation is entered within your username and password. The submitted calculation may be from any site in the state.

The “Confirmation #” is assigned to all submitted calculations. Enter this number to view submitted calculations from other Calculator users. You must have the confirmation # to view a calculation submitted by another user.

Submitted calculations have no data entry or calculation buttons. So, the evaluations and results may not be altered after the calculation is submitted.

2 CLOSURE PROCESS

The goal of any RISC sampling procedure is to reach closure or determine if further action is necessary at a particular site. The closure process has three main steps (evaluations), screening, nature & extent and closure. To display the site evaluation process, choose the “Enter Calculation” button from the List of Active Calculations screen. The calculation contains the three process steps, screening, nature and extent, and closure as shown on the Screen Layout screen.

2.1 CLOSURE PROCESS -VS- CALCULATION:

Chronologically and typically the evaluations will be completed in order (screening/nature and extent/closure). However, if an evaluation result of "closure" is reached within any of the three evaluation steps, the site is eligible for closure, for the chemical and media evaluated. In turn, a "closure" result must be reached at some point in the process before a site may close.

Within each closure process step, any individual or all of the three media, surface soil, subsurface soil, or groundwater may be evaluated within one calculation. So, there are 9 basic evaluations offered in each calculation, 3 process steps and 3 media in each step.

2.2 SCREEN LAYOUT

The Screen Layout provides navigation to all screens of the calculation. To begin the calculation, all screens under "Initial Inputs" must be completed and SAVED before Sampling Evaluations may be performed.

As stated on the Main Page, a Calculation is a collection of all evaluations, some evaluations, or any single evaluation(s) shown on this Screen Layout. The calculation may also include data collected over many years as well, as typically seen in groundwater closure evaluations.

2.3 AUTO-DATA

The Auto Data Entry (Electronic File Upload) function uses an Excel spreadsheet to provide automatic entry of sampling data. Sampling data for all three media and all three evaluation steps may be uploaded in this manner, except subsurface background data. The same Excel file can be used to load multiple evaluations as well. So, the same data file can be used to screen, define the extent of contamination, or close.

Closure and screening data can be directly loaded via auto-data. However, to load nature and extent data, nature and extent data must first be entered into closure via auto-data, then "imported" into nature and extent (as noted in the information box below the Nature and Extent Groundwater evaluation). This function is performed by using the "import data from closure" buttons within the individual nature and extent screens.

Sampling data may be entered electronically in pieces or sets as well. So, you can enter one file for subsurface soil borings B1, B2, and B3, then enter another file containing boring B4, B5, and B6 at a later time. Or, you can also enter borings B1, B2, B3, and groundwater wells W1, W2, W3 using one file.

NOTE:

New data entered into an existing location will replace the existing data. For instance, if boring B2 already contains data, then you enter new data for boring B2, the new data will erase and replace the original data (as is typical in a web-application). So, as long as you enter data for a new location, all existing data will remain unchanged.

- Auto-data Features: Creates all screens (except background) and enters all data.

2.4 PEC AND CLOSURE PROCESS

A Potential Exposure Concentration (PEC) is a chemical concentration representing the impact of one chemical upon the entire site. For the same chemical, the closure level is a threshold concentration that determines whether an impact is threatening for a receptor. More simply stated:

> **The PEC is the sampling result, and the closure level is the sampling result limit.**

Within each evaluation, a single concentration is determined for each sampling location, according to the particular sampling method used for that location. The PEC is calculated from this group of location concentrations, and is a single site-wide sampling result.

> **For all media, surface soil/subsurface soil/groundwater, and for all evaluations, screening/nature & extent/closure:**
>
> **If the PEC is below the Closure Level, the site is eligible for closure, for the chemical and media evaluated.**

For instance, assume that you are performing a subsurface screening evaluation using a weighted average boring sampling method. You will select the “weighted average” method from the Summary for Boring screen. The Calculator then calculates the weighted average concentration of all samples within each boring (sampling location). So, you now have a set of borings and boring concentrations. The Calculator will then determine the PEC, a site-wide concentration, from the set of weighted averages. Then the Calculator compares the PEC to the closure level to determine whether the site chemical should close or perform further action.

- After screening, further action is typically the nature and extent evaluation.

2.4.1 Non-Default Evaluations:

The Calculator performs certain non-default evaluations using automatic calculations for surface and subsurface soils. If a manually calculated non-default closure level is to be used, the non-default submittal should look identical to a background nature and extent evaluation. The best format for this evaluation is shown in the Calculator's nature and extent screens. Using this background evaluation format will provide a clear and easily understood submittal.

2.4.2 Site Summaries:

The screening and closure site summaries each contain a table showing evaluation results for all three media. The Site Summary Table shows the process status of each media. For instance, in the screening site summary, surface soil may be shown as eligible for closure, while the subsurface and groundwater may show that a nature and extent evaluation is necessary. So, no further action is necessary for surface soil, but subsurface soil and groundwater require more sampling and analysis to determine the nature and extent of contamination.

Unless the closure site summary shows that the media is eligible for closure, further evaluation is necessary. Results from screening and nature and extent evaluations are transferred to the Closure Site Summary. If the results for screening or nature and extent attain closure, then a closure evaluation is not needed, for the particular chemical and media evaluated.

The nature and extent site summaries are shown within each media evaluation. For example, the site summary for surface soil is on the surface soil nature and extent summary screen, and the subsurface site summary is shown on the subsurface soil nature and extent summary screen.

2.4.2.1 BACKGROUND CLOSURE SITE SUMMARIES:

The background nature and extent site summaries also show the background chemical nature and extent site evaluation summaries, as well as the background closure summaries. Background evaluations are performed in all three nature and extent media, and surface and groundwater closure, but not subsurface closure. Background subsurface closure is performed in the nature and extent screens for convenience.

2.4.3 Groundwater Closure: (stability monitoring and attenuation modeling)

This guide does not contain instructions for stability monitoring or attenuation modeling at the present time. These two groundwater closure options are detailed in the RISC Technical Guide, Appendix 3. The Calculator's associated screens closely follow the Technical Guide's instructions. These two sections will be added to this guide as soon as possible.

2.5 INITIAL INPUTS

Click on each Initial Input screen highlighted. These screens will be highlighted in sequence after completing and saving the previous screen. Click "Calculate Closure Levels" after completing all Initial Input Screens, and the Sampling Evaluation screens will be activated (highlighted).

> **After changing any initial input screen, all initial inputs screens should be saved and the closure level should be recalculated.**

2.5.1 Site Information:

This screen establishes some of the site wide evaluation criteria. Calculator evaluations depend on whether the site is residential or industrial, source area size of less than 1/2 acre or not, a petroleum site or not, and what kind of petroleum products were managed. Select the applicable choices shown in the pull-down boxes.

If the site is a petroleum site ("Yes" is chosen), the Attenuation Model option will be allowed in ground water evaluation, and the Step-out subsurface investigation procedure including the Mean + Standard Deviation evaluation method will be used by the Calculator. (See Subsurface Closure Evaluation for the LUST Step-out Procedure Instructions.)

- The free product pull-down box is for information purposes only. The Calculator evaluations are not altered by this box.
- If the Site Information is changed, all screens under Initial Inputs should be resaved and closure levels recalculated.
- The Calculator evaluation process will not proceed unless "Save Changes" or "save" is pressed on each screen.

2.5.2 Chemical Selection:

Select the chemicals to be evaluated at the site on this screen. The calculator has a 25 chemical limit. Chemicals having only non-detect results may also be added to allow a comprehensive evaluation and report.

2.5.2.1 PETROLEUM CHEMICALS:

If petroleum is selected in the Site Info screen, a predetermined list of chemicals will be automatically entered in the List of Selected Chemicals. Other chemicals may be added to the list as well.

- Napthalene should be added to all petroleum evaluations if not automatically entered by the Calculator.
- TPH is not yet available to the Calculator, but can be manually evaluated using the same logic and calculations as other chemicals.

2.5.2.2 AUTO-DATA UPLOADS:

Auto-Data will load data for chemicals which are not initially selected. If data is uploaded for a chemical which was not selected on this screen, and if the chemical needs to be added to the calculation, then the chemical must be added on this screen, AND the "Calculate Closure Level" hyperlink must be executed from the Screen Layout.

The Quick Data Excel file must contain the exact chemical name used in the Calculator. The quick data file has a complete list of exact names in one of its worksheets.

- If any chemicals are added or removed, all screens under Initial Inputs may need to be resaved and closure levels recalculated.

2.5.3 Input pH Levels for Metals:

Given that the Kd value for some metals varies based on the pH levels, please select the pH level that is representative of the on-site pH.

- The default pH is 6.8.

2.5.3.1 PH OUTSIDE OF DEFAULT RANGE:

The risk calculator does not support calculations with pH levels falling outside the ranges listed in the screen. In this case, it may be possible to use the pH and Kd from this screen as long as the associated manually calculated closure level is smaller than the Calculator's closure level.

Or, a non-default supplemental report may be submitted to IDEM. For the non-default report, if a manually calculated non-default closure level is to be used, the non-default submittal should look identical to a subsurface background evaluation, which the Calculator performs in the nature and extent screens. Using this background evaluation format will provide a clear and easily understood submittal.

- If the pH is changed, all screens under Initial Inputs should be resaved and closure levels recalculated.

2.5.4 Input Non-Default Parameters

These parameters change the default closure levels for surface and subsurface soil, but not groundwater. This screen changes the values for the default exposure parameters of the default exposure equations. All soil evaluations, in terms of equations and logic for surface and subsurface soil, remain the same, but use a different closure level.

- In non-default evaluations, changes made to the site parameters do not change the surface soil Volatilization Factor and/or Particulate Emission Factor.
- If the parameters are changed, all screens under Initial Inputs should be resaved and closure levels recalculated.
- The equations and parameters are discussed in more detail in Chapter 7 of the RISC Technical Guide.

2.5.5 Calculate Closure Levels:

If any of the initial inputs are changed, this Calculate Closure Levels hyperlink should be pressed (executed). Closure Levels can also be re-calculated on the View Closure Levels screen.

3 SCREENING:

3.1 OVERVIEW:

When a screening evaluation is used, it is the initial sampling investigation procedure for a site. Though not required, screening is typically used when a site is suspected of contamination, but it is not clear if the chemical impact is above the contamination threshold (the closure level).

The advantage of beginning the investigation with a screening evaluation before a nature and extent evaluation is that screening requires fewer samples (fewer costs), and that sites may be eligible for closure from a screening evaluation. The drawback between the two is that screening does not determine the nature and extent of contamination. So, if contamination is certain at a site, the site investigation should probably begin with the nature and extent evaluation to avoid the cost of screening.

3.1.1 Media Screening:

As in all three steps of the closure process, the screening evaluation may be conducted for only one, any two, or all three media: surface soil, subsurface soil, and/or groundwater.

3.1.2 PEC -vs- Closure

A Potential Exposure Concentration (PEC) is a chemical concentration representing the impact of one chemical within the entire site. For all media, surface soil/subsurface soil/groundwater, and for all evaluations, screening/nature & extent/closure:

> **If the PEC is below the closure level, the site is eligible for closure, for the chemical and media evaluated. If above, further action is required.**

3.1.3 Screening Evaluations

Screening evaluations are shown as hyperlinks on the screen layout. Screening evaluations and associated PEC methods are summarized as follows:

SURFACE SOIL:

.....Methods (3): Max Concentration, Max Test, Chen Test

SUBSURFACE SOIL:

.....Methods (2): Max Weighted Average, Increment Average

GROUNDWATER:

.....Methods (1): Max Concentration:

NOTE: Groundwater PEC is compared to the detection limit, not Closure Level to determine further action.

3.1.4 Further Action -vs- Closure:

Further action means that closure is not allowed. Further action refers to activities which should be performed prior to attempting closure evaluation again. Options for further action typically include:

- Nature and Extent (typical after screening)
- Non-default risk assessment
- Re-sampling, or Remediation.

3.1.5 Default -vs- Non-Default Screening:

Screening should be performed using either of the default or non-default residential closure levels, as long as the closure levels are calculated by the Calculator. If using a non-default closure level, a sampling supplement should be submitted demonstrating that the new soil parameter is representative of typical source area soil.

3.1.6 Sampling Method: Random -vs- Judgmental Sampling:

Evaluations offering random sampling contain a screen which selects between random and judgmental sampling. Random sampling is an option in screening, surface soil only; and closure, surface and subsurface soil only.

The sampling area is always chosen using site knowledge and professional experience (professional judgment). After the sampling area is chosen, random sampling methods use an area grid and randomly select grid points as sampling locations. In judgmental sampling, the same sample area is used, but sample locations are selected using site knowledge and investigation experience (professional judgment).

- If locations are chosen using judgmental sampling, the random sampling evaluation methods may not be used.

3.1.7 Additivity:

Additivity is performed in closure only.

3.1.8 Petroleum Sites:

3.1.8.1 FOR SOILS:

Petroleum sites do not use soil screening as a separate step of the closure process. Screening, nature and extent, and closure are normally combined in the LUST Step Out procedure (see Subsurface Closure Evaluation as well as the RISC User Guide, LUST Chapter).

3.1.8.2 FOR GROUNDWATER:

Use the Calculator's groundwater screening evaluation. As in all groundwater screening evaluations: To determine closure or further action, the PEC is compared to the detection limit, not the closure level.

3.2 SURFACE SOIL SCREENING (HYPERLINK):

(hyperlink on Layout):

The surface soil nature and extent evaluation (hyperlink on Screen Layout) is performed by four (4) screens. Screens and PEC methods are shown below:

Surface Soil Sampling Method:

.....Methods: None

Surface Soil Screening Summary

.....Methods: None

Surface Soil Screening Inputs

.....Methods (3): Max Concentration, Max Test, Chen Test

Surface Soil Screening Results

.....Methods: None

3.2.1 Sampling Method: Random -vs- Judgmental Sampling:

This screen provides sampling evaluation methods based on random or judgmental sampling. The sample area is always chosen judgmentally. Within the sample area, the sample locations are chosen either randomly or judgmentally.

- If locations are chosen using judgmental sampling, the random sampling evaluation methods may not be used.

3.2.2 Screening Summary:

The screening summary shows the chemical sampled and tested, the closure level, the site-wide PEC, the evaluation method, and the sampling location concentrations in a table. The first row under the concentration boxes shows the sample location name or number.

As in all RISC Calculator evaluations, if the PEC is lower than the closure level, the site is eligible for closure. So this screen shows which chemicals are eligible for closure and which require further action (typically nature and extent evaluation).

3.2.3 Screening Inputs:

To perform the initial evaluation, press the Add/Edit Data button to move to the screening inputs screen. Sample locations and concentrations are entered here, and the method of evaluation is also selected here. Only one concentration may be entered for each sampling location.

The following three evaluation methods are used in surface screening:

MAXIMUM CONCENTRATION for judgmental sampling: The PEC determined for this method is the highest concentration entered on this screen. There is no minimum or maximum number of samples for this method.

- This test is valid for all RISC chemicals.

MAX TEST for random sampling only: The max test uses 32 individual samples that are combined into 8 composite samples (4 samples in each composite), then sent to the lab. Typically, 8 sample concentrations will be entered for the max test. The PEC is the highest composite concentration entered. However, the PEC is compared to the closure level divided by the number of samples in each composite sample, instead of just the closure level.

- This statistical test is valid for non-volatile chemicals only, since samples are open to the atmosphere as composite samples are created.

CHEN TEST for random sampling only: The chen test uses 12 individual samples. So, typically, 12 concentrations are entered for the chen test. The chen test does not calculate a "PEC" concentration, but produces an equivalent site result (the chen mean) that is used in place of the PEC -vs- closure level evaluation.

- This statistical test is valid for all chemicals since samples are collected individually (not composites), and are not open to the atmosphere for a long time.

3.2.4 Screening Results:

This screen shows the results of the surface soil PEC calculations (and chen mean), logs the test method, and the site evaluation after comparing the PEC to the closure level. The result column also provides a few instructions, such as "need at least 8 samples" for the max test.

NOTE:

See the RISC Technical Guide, Chapter 3 for further instruction on screening, including all equations and explanation for the statistical tests.

Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

3.3 SUBSURFACE SOIL SCREENING: (HYPERLINK)

This evaluation determines whether the subsurface soil requires further action or whether the site is eligible for closure. In this evaluation, the Calculator determines a boring concentration representing all sample concentrations within the boring. Then using the set of boring concentrations, determines a site concentration, the site PEC, representing all boring concentrations within the site.

3.3.1 Screens and PEC Methods:

Subsurface screening uses four screens. Screens and site PEC methods are listed below:

Add/Edit Subsurface Soil Borings

.....No Methods

Summary for Boring (boring name)

.....PEC Methods: Weighted Average & Increment Average

Inputs for (boring name) and

.....No Methods

Results for (boring name).

.....No Methods

3.3.2 Random –vs- Judgmental Sampling:

Random sampling is not performed in subsurface screening or groundwater screening.

3.3.3 Add/Edit Subsurface Soil Borings:

This screen creates boring names and changes boring names. The RISC Calculator does not use random sampling for subsurface screening. All boring locations are chosen using professional judgement. The "Save Edits" button returns to this same screen and is used when a large number of borings are evaluated. The Accept Boring Names button saves the boring names, then displays the Summary for Boring screen (use when editing is finished).

3.3.4 Summary for Boring (boring name):

This screen selects the evaluation method "Method" column, and displays the evaluation results as well. The Avg/PEC column displays boring concentrations as well as the site PEC. Because they are so closely related, these two results, the boring concentration and the site PEC, are displayed in the same column on this summary screen.

When the evaluation results are displayed, a "*" inside the Avg/PEC result box distinguishes whether the result is a boring concentration average alone or also a PEC. A result without a "*" is only weighted average boring concentration, and is not a PEC. A result with a "*" is the site PEC. The PEC evaluation details are discussed in PEC Methods.

3.3.4.1 BORING CONCENTRATION METHODS:

For a single boring, there are basically two boring sampling methods "Methods column", and two associated method results "Avg/PEC column". The term Increment Average" found in the "Method" selection boxes, refers to a site PEC method (discussed in PEC Methods). The term "Weighted Average" refers to both a boring method result and a site PEC result.

Each of these PEC methods uses results from one of the two boring methods below as inputs for the PEC calculation:

WEIGHTED AVERAGE: The result, a concentration, from all lab analyzed samples within a boring*, OR

INCREMENT MAXIMUM: The lab - analyzed result, a concentration, from the boring's field sample increment having the highest field reading** (only one lab result is required from each boring).

> * In the weighted average method, all samples within the boring are sent to the lab, and all lab sample concentration results are entered into the Subsurface Screening Inputs screen (Add/Edit button). Using these concentrations, the weighted average is:
>
> Weighted Average = Sum of (increment lengths x increment concentrations) / Sum of (increment lengths).
>
> Non-detect concentrations are not evaluated in the weighted average method, but may be entered (as "ND").
>
> ** The Volatile Field Screening sampling procedure must be used when determining the increment maximum. In this method, each boring sampling increment is field screened (eg, a PID instrument). The increment sample having the highest field reading (increment maximum) is sent to the lab. This lab concentration is entered as the boring concentration. The Calculator's increment average method will accept more than one concentration entered for each boring, but will select the highest concentration entered as the boring concentration.
>
> See the Subsurface Screening Clarification at:
> http://www.in.gov/idem/land/risc/techguide/index.html

3.3.5 Subsurface Screening Inputs for Boring:

(Site-wide PEC Evaluations)

The site PEC is a evaluation of all location concentrations, and is a site - wide concentration. In subsurface soil, the locations are simply the borings names. After entering sampling data, Site PECs are determined using one of the following two evaluations:

MAX WEIGHTED AVERAGE: Using the three boring weighted averages, the calculator selects the highest of the three as the PEC. RISC suggests using three boring weighted averages for this PEC, although the Calculator will accept more than three.

INCREMENT AVERAGE (Volatile Chemicals only): Select the 3 highest increment maximums out of all borings screened. The PEC is the average of these three increment maximums.

- These two methods are chosen on the Summary for Boring screen.

3.3.6 Subsurface Screening Inputs for Boring:

3.3.6.1 BORING LOG INPUTS

Of the three boring log parameters, increment length/sample depth/stratum range, only the increment length is used in the weighted average calculation. Sample depth and stratum range are used in the increment length calculation executed by the auto data process, but not for the weighted average calculation. These two are provided on this screen for information purposes only. Definitions and descriptions are discussed below:

Increment length:

The increment length is the length of the boring represented by one sample. Increment lengths are not determined until sampling of the boring is completed. The top of the top increment in the boring is always the surface. The bottom of each increment length is either the midpoint between the increment's sample depth and the following increment's sample depth, or the bottom of the stratum containing the increment's sample.

An increment cannot cross a stratum boundary. Also, only one increment is assumed for each sample. So, the number of increments = the number of samples. And, the sum of the increment lengths within one stratum = the stratum length.

Sample Depth:

The sample depth is the depth that the sample was collected during field sampling. For a sample cut from a long section of the boring core, such as a two foot long sample, use the midpoint between the top and bottom of the length of the sample. For instance, assume you drill two boring cores, each 2 feet long, and extending from 2 to 4 feet, and 4 to 6 feet. And assume that the entire length of each 2 foot core is sampled. Then, the sample depth entered into the calculator would be 4 feet. 4 feet is the midpoint between 2 (the sample top) and 6 (the bottom).

Stratum Range:

The stratum range (plural = strata) is the top and bottom depth (boundaries) of the stratum. The range is entered as "topdepth - bottomdepth", with a hyphen in the middle (Note: html does not display a hyphen).

The stratum ranges may not overlap, but they can use the same value as a boundary. Example, range 1: 0 - 3 feet, range 2: 3 - 8 feet.

NOTE: Niether the sample depth nor the stratum range are used ON THIS SCREEN to calculate the increment length. Increment length can be calculated using the Quick Data file.

3.3.6.2 BORING LOG DATA EXAMPLES:

2 Strata, 2 Samples:

The geologic strata in a particular boring consists of a sand stratum and a silt stratum. The sand stratum extends from the surface to 4 feet below the surface. The silt stratum extends from 4 feet to 10 feet. One sample is taken from each stratum. The sand is sampled at a depth of 1 foot, and the silt is sampled at a depth of 8 feet.

In this case, the strata range for sand is 0 - 4 feet, and 4 - 10 feet for silt. The sample depth for sand is 1 foot and 8 feet for silt. The increment length is 4 feet for sand and is 6 feet for silt (since one increment length is assigned to each sample).

Multiple Samples within Stratum:

Assume the above scenario, except that 2 samples are taken within the silt stratum, one at 5 feet and the same sample at 8 feet.

In this case, the sand increment length stays the same, since increments may not cross a stratum border. But, within in the silt stratum, since there are two silt samples, there are two silt increments. The first increment extends from the stratum top, 4 feet, to the midpoint between the 5 foot and 8 foot sample depth, or 6.5 feet. The second increment extends from 6.5 feet to the bottom of the stratum, or 10 feet. So, the increment length for the first sample is 2.5 feet (4 - 6.5), and the increment length for the second is 3.5 feet (6.5 - 10).

See the "Quick Data" Excel file for further explanation on proper sample data entry.

3.3.7 Subsurface Screening Results:

This screen displays the PEC method results, showing the Closure Level, the PEC method, and the PEC result.

> **As in all Calculator evaluations, if the PEC is above the closure level, the site is eligible for closure, for the chemical and media evaluated. If below, the site requires further action.**

3.4 GROUNDWATER SCREENING (HYPERLINK)

3.4.1 Screens and Methods:

The groundwater screening evaluation is simple and uncomplicated. The groundwater screening evaluation (hyperlink on Screen Layout) is performed by three (3) screens. Screens and PEC methods are shown below:

Groundwater Screening Summary
.....Methods: None
Groundwater Screening Inputs
.....Methods: None
Groundwater Screening Results
.....Methods: (1) Max Concentration

These screens operate in the same manner as the soil screens as well. Although the evaluation is easy, the Calculator provides a consistent report of this media with all other media and evaluations.

3.4.2 Groundwater Screening Results (PEC Evaluation):

The PEC evaluation method is as follows:

MAX CONCENTRATION: The PEC is the highest concentration result from all wells.

If all analytical concentration results are below the detection limit, the chemical is eligible for closure.

Any chemical which is detected in the site groundwater requires further action, typically a nature and extent evaluation.

- Only one input is necessary for each chemical at the site.

3.4.3 Screening Site Summary:

Groundwater screening results for the site are shown on the Screening Site Summary.

4 NATURE AND EXTENT

4.1 OVERVIEW:

The nature and extent of contamination evaluation is the second major step in the closure process, typically occurring after screening and before closure. Unless a site demonstrates closure using screening, the nature and extent of contamination must be determined prior to a closure demonstration.

The nature and extent evaluation determines the boundary between sampled areas above closure levels and sampled areas below closure levels. A sample concentration is determined for each sample location, and that location is then designated as contaminated or not contaminated. Once all required locations have been designated, the site has completed the nature and extent evaluation.

4.1.1 Media Nature and Extent:

As in all three steps of the closure process, the nature and extent evaluation step may be conducted for only one, two, or all three media: surface soil, subsurface soil, and/or groundwater.

4.1.2 PEC -vs- Closure

A Potential Exposure Concentration (PEC) is a chemical concentration representing the impact of one chemical within the entire site. For all media, surface soil/subsurface soil/groundwater, and for all evaluations, screening/nature & extent/closure:

> **If the PEC is below the closure level, the site is eligible for closure, for the chemical and media evaluated; If above, further action is required.**

4.1.2.1 NATURE AND EXTENT EVALUATIONS

Nature and extent evaluations are shown as hyperlinks of the screen layout. Evaluations and methods are summarized as follows:

SURFACE SOIL:
.....Methods(1): Each Location Concentration

SUBSURFACE SOIL:
.....Methods (1): Each Boring Concentration

GROUNDWATER:
.....Methods (1): Each Well Concentration

PEC Method: If all locations are not contaminated, the site is not contaminated and is eligible for closure.

4.1.2.2 SITE SUMMARIES FOR NATURE AND EXTENT

The nature and extent site summaries are shown within each media evaluation. For example, the site summary for surface soil, which is shown as "Site Result" is on the surface soil nature and extent summary screen, and the subsurface site summary is shown on the subsurface soil nature and extent summary screen.

Sites may close using a nature and extent evaluation. Results are transferred from nature and extent to the Closure Site Summary screen.

- The nature and extent site summaries also show the background site results.

4.1.2.3 RANDOM -VS- JUDGMENTAL SAMPLING:

Random sampling is not performed or evaluated in nature and extent investigations.

4.1.2.4 FURTHER ACTION -VS- NATURE AND EXTENT:

Further action means that closure is not allowed. Further action refers to activities which should be performed prior to attempting the nature and extent evaluation again. Options for further action typically include:

- Re-sampling
- Remediation.

4.1.2.5 INDUSTRIAL -VS- RESIDENTIAL NATURE AND EXTENT:

Nature and extent evaluations always use the residential closure level to determine whether a location or a site is contaminated

4.1.2.6 ADDITIVITY & CLOSURE:

Additivity is performed in closure only.

4.1.2.7 PETROLEUM SITES:

For soil, petroleum sites typically use the LUST Step-out procedure. Although petroleum sites may attain closure using only one sampling event, two evaluations are required: a nature and extent evaluation and a closure evaluation. So, petroleum sites should complete both the nature and extent subsurface and the closure subsurface screens to demonstrate closure.

This procedure is detailed in the Subsurface Closure evaluation, as well as the RISC User Guide, LUST Chapter.

4.2 SURFACE SOIL NATURE AND EXTENT (HYPERLINK)

The surface soil nature and extent evaluation (hyperlink on Screen Layout) is performed by three screens:

Surface Soil Nature and Extent Summary
.....Methods (1): Max Concentration

Surface Soil Background Closure Level Calculation
.....Methods (1): Average + 1 Standard Deviation (this is a closure level)

Surface Soil Nature and Extent Inputs.
.....Methods: None

4.2.1 Nature and Extent Summary:

This screen is both a summary and a calculation results screen, since no calculation equations are used, and since only one concentration is entered for each location, and this concentration is directly compared to the closure level.

The nature and extent summary shows the chemical sampled and tested, the closure level, the extent sampling locations and concentrations, and the site result (using the site PEC) in a table. The first row under the concentration boxes shows the sample location name or number.

- Nature and extent does not have a Site Summary screen. Site summaries are shown on each media summary. The surface soil summary is also the site summary.

4.2.1.1 LOCATION AND PEC EVALUATION METHOD:

In nature and extent evaluations, each location is evaluated as well as the entire site. Each location concentration is compared to the residential closure level, and the PEC is compared to the residential closure level. For the site evaluation, the PEC is the highest concentration at the site.

Location Method: Each location concentration

If the location concentration is above the closure level, the location is contaminated, and if below, the location is not contaminated.

PEC Method: Maximum Concentration

If the PEC is above the closure level, the site is contaminated, and if below, the site is not contaminated. The Site Result column shows this result.

4.2.1.2 NON DEFAULT EVALUATIONS:

Non-default methods use the residential surface risk based closure level (RBL). In turn, the subsurface non-default nature and extent method also uses the RBL. See the View Closure Levels screen for RBL info.

4.2.2 Surface Soil Background:

Press the Background button to calculate a background chemical closure level. This screen requires sample locations and concentrations only. Load data and press Save and Calculate to produce a background (BG) level. The statistical calculation used is:

Background Closure Level = Average concentration + 1 Standard deviation.

- After the background closure level is calculated, it is not used unless selected for use on the Inputs screen (see below).
- At least 4 samples are required for this calculation.
- Use 1/2 detection limit for non-detect concentrations.

4.2.3 Nature and Extent Inputs:

To enter sampling data, press the Add/Edit Data button to move to the nature and extent inputs screen. Locations and concentrations are entered here, and only one concentration may be entered for each sampling location. Notice that there is no choice for the evaluation method, since no calculation exists and the evaluation is always a simple a closure level comparison.

- For non-detect concentrations, use the symbol "ND" in place of a number. Any number entered is assumed to be above the detection level.

4.2.3.1 BACKGROUND CLOSURE LEVEL:

Once the background closure level is calculated, it is not used unless selected for use on this screen. The closure level column provides two choices, background level (BG), or calculated level (CL). If background is chosen, it replaces the Calculator's calculated closure level for this surface soil evaluation only. Although a closure evaluation may use this background closure level, this level must be selected again in the closure evaluation.

- A background evaluation requires both a background closure level and background location concentrations (from contaminated zone).

4.2.3.2 RANDOM -VS- JUDGMENTAL SAMPLING:

None of the nature and extent evaluations use random sampling. Sampling locations are chosen by professional judgement.

4.2.3.3 NUMBER OF SAMPLE LOCATIONS REQUIRED TO DEFINE NATURE AND EXTENT:

Two types of locations are needed, contaminated locations and uncontaminated locations (result of not contaminated). In the sampling procedure, sampling locations are chosen in four principal directions from the source (center) of contamination. As implied in the title, sampling continues in each of the four directions until an uncontaminated location is reached (until the "extent" is reached).

So, in all cases, a completed nature and extent soil evaluation requires the minimum number of locations above the closure level, and at least four locations below. Requirements are based on sample area size and are as follows:

Area Size and # Locations:

Area Size	**No. Contaminated Locations**	**No. Un-contaminated Locations**	**Total Locations**
0.5 acre or smaller	10	4	14
0.25 acre or smaller	5	4	9
0.1 acre or smaller	3	4	7

NOTES:

- The results shown on the Surface Soil Summary screen should include the required number of sample locations.
- The residential closure level is always used as the closure level for nature and extent evaluations.
- All nature and extent evaluations should choose "Residential" in the Site Information screen.
- Using the location concentration results, the extent of contamination can be defined and delineated on a site map.
- See the RISC Technical Guide, Chapter 4 for further instruction on nature and extent evaluation. Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

4.3 SUBSURFACE SOIL NATURE AND EXTENT (HYPERLINK)

4.3.1 Overview:

This evaluation determines whether the subsurface soil requires further action or whether the site is eligible for closure. Further action means either further sampling and assessment, a nondefault assessment, or remediation. The Calculator can be used for either further assessments and certain non-default assessments.

In this evaluation, the Calculator determines a boring concentration representing all sample concentrations within the boring. Then using this set of boring concentrations, determines a site concentration, the site PEC, representing all boring concentrations within the site. The PEC is then compared to the closure level to determine further action or closure.

4.3.1.1 BACKGROUND

Background chemicals are evaluated stratum by stratum, and a site wide PEC is calculated for each stratum. A simple way to imagine the background site evaluation is to view each stratum as a separate site. For instance, if one site has three strata (plural of stratum), the Calculator acts as if three sites are on top of each other, one site for each stratum. Subsurface background is described in more detail in the Background PEC Methods discussion.

4.3.1.2 AUTO-DATA

Except for background nature and extent chemicals, all closure and nature & extent sampling data can be electronically entered using an Excel file and the Auto-data electronic function. Closure data can be directly loaded via auto-data, however nature and extent data must be electronically entered into closure via auto-data, then "imported" into nature and extent using the "import data from closure" buttons within the nature and extent screens.

4.3.1.3 SCREENS AND EVALUATIONS

This evaluation contains ten (10) screens. Screens and Evaluation Methods are summarized below:

Add/Edit Subsurface Soil Borings:
.....No Method

Background Add/Edit Soil Borings:
.....No Method

Subsurface Nature and Extent Summary
.....Default PEC Methods: Max Weighted Average OR Max Increment Max

.....Background PEC Methods: Max Weighted Average OR Average + 1 Standard Deviaton

Choose Closure Level Type:
.....No Method

Subsurface Background Closure Level Calculation:
.....Method: Average + 1 Standard Deviation

Subsurface Summary for Boring AND
& Subsurface Inputs for Boring:
.....Methods: Weighted Average OR Increment Max

Subsurface Summary for Boring at Stratum AND
& Subsurface Inputs for Boring at Stratum:
.....Methods: Weighted Average OR Increment Max

4.3.2 Add/Edit Subsurface Soil Borings:

This screen creates boring names and changes boring names. The RISC Calculator does not use random sampling for subsurface nature and extent evaluations. All boring locations are chosen using professional judgement. The "Save Edits" button returns to this same screen and is used when a large number of borings are evaluated. The Accept Boring Names button saves the boring names, then displays the nature and extent summary screen.

4.3.3 Background: Add/Edit Subsurface Soil Borings:

This screen is used if background chemicals are evaluated. The difference between this background screen and the "Borings" screen above, is the "Number of Strata" entry box. Strata refers to the soil types stacked within the subsurface soil being sampled. The number of strata applies to the entire site. So, if three is entered for the number of strata, then three strata are evaluated for each boring within the site.

4.3.4 Nature and Extent Summary:

This screen summarizes the site results for each boring, all background strata, all chemicals, and the entire site. Default closure level chemicals are displayed above the set of background chemicals.

Unlike screening and closure, which have only one summary screen, the site PEC is determined on this summary screen. This screen is essentially the screening and closure site summary screen for nature and extent, except that only one media is summarized. Surface soil and groundwater nature and extent have similar individual media summary screens.

- The site summary is evaluated after creating each boring concentration (summary for boring screens). So, as in screening and closure, the summary for borings are discussed first:

4.3.5 Background Closure Level:

Choosing background creates strata within the nature and extent summary. Each strata is assigned a background closure level, calculated by the following screen. After calculating the boring at stratum concentration, the Calculator compares the stratum PEC to the background closure level.

4.3.5.1 SUBSURFACE BACKGROUND CALCULATION:

This screen is identical to the surface soil background screen, except that a separate background closure level is assigned to each site stratum. The Calculator treats each stratum as if were a site without background chemicals. Each stratum has its own closure level and its own PEC.

Background Closure Level Calculation Method::

Background Closure Level = average + 1 standard deviation.

4.3.6 Summary for Boring: AND
Summary for Boring at Stratum

This screen determines a boring or stratum concentration representing all sample concentrations within the boring or stratum.

The boring at stratum screen works identically to the boring screen and uses the same boring methods and concentrations and inputs. To follow stratum instructions, simply substitute the word stratum for boring in the boring methods and boring log inputs instructions.

4.3.6.1 BORING METHODS AND CONCENTRATIONS

For a single boring, there are basically two boring sampling methods "Methods column", and two associated method results "Result column". The PEC methods, including background strata PECs, use one of the two boring methods below:

> WEIGHTED AVERAGE (includes background): The result, a concentration, from all lab-analyzed samples within a boring*. The weighted average also applies to background evaluations.
>
> INCREMENT MAXIMUM: The lab-analyzed result, a concentration, from the boring's field sample increment having the highest field reading** The increment max does not apply to background. Only one lab result is required from each boring.

If only one sample is taken from a stratum, use the weighted average method. The weighted average of one value is the value itself.

> * In the weighted average method, all samples within the boring are sent to the lab, and all lab sample concentration results are entered into the Subsurface Closure Inputs screen (Add/Edit button). Using these concentrations, the weighted average is:
>
> Weighted Average = Sum of (increment lengths x increment concentrations) / Sum of (increment lengths).
>
> Non-detect concentrations are not evaluated in the weighted average method, but may be entered (as "ND").
>
> ** The Volatile Field Screening sampling procedure must be used when determining the increment maximum. In this method, each boring sampling increment is field screened (eg, a PID instrument). The increment sample having the highest field reading (increment maximum) is sent to the lab. This lab concentration is entered as the boring concentration. The Calculator's increment average method will accept more than one concentration entered for each boring, but will select the highest concentration entered as the boring concentration.
>
> See the Subsurface Screening Clarification at:
> http://www.in.gov/idem/land/risc/techguide/index.html

4.3.6.2 RANDOM/JUDGMENTAL SAMPLING:

Nature and Extent (N&E) Evaluations do not use random sampling, hence all N&E evaluations use judgmental sampling to determine sample locations.

4.3.6.3 METHOD SELECTION:

As in all subsurface evaluations, screening, nature and extent, and closure, the method selection is done on the first boring entered for the site. All other borings at the site use the same method for a particular chemical. Note that each chemical may use a different boring evaluation method.

NOTES:

- If the boring concentration is larger than the residential closure level, the boring (only that location) is contaminated, and if smaller, the boring is not contaminated.
- Except background chemicals, the default residential closure level is always used as the contamination level in nature and extent evaluations. This is true for all media: surface soil, subsurface soil, and groundwater.
- Background chemicals use the background closure level as the contamination level.

4.3.7 Nature and Extent Inputs for Boring AND Nature and Extent Inputs for Boring at Stratum:

The instructions for the boring and boring at stratum screens are identical.

To enter sampling data, press the Add/Edit Data button on the summary for boring to move to the nature and extent inputs screen. Locations and concentrations are entered here, and only one concentration may be entered for each sampling location (within the boring). Notice that there is no choice for the evaluation method, which was selected on the boring summary screen.

4.3.7.1 BORING LOG INPUTS

Of the three boring log parameters, increment length/sample depth/stratum range, only the increment length is used in the weighted average calculation. Sample depth and stratum range are used in the increment length calculation executed by the auto data process, but not for the weighted average calculation. These two are provided on this screen for information purposes only. Definitions and descriptions are discussed below:

Increment length:

The increment length is the length of the boring represented by one sample. Increment lengths are not determined until sampling of the boring is completed. The top of the top increment in the boring is always the surface. The bottom of each increment length is either the midpoint between the increment's sample depth and the following increment's sample depth, or the bottom of the stratum containing the increment's sample.

> An increment cannot cross a stratum boundary. Only one increment is allowed for each sample. The number of increments = the number of samples. The sum of the increment lengths within one stratum = the stratum length.

Sample Depth:

The sample depth is the depth that the sample was collected during field sampling. For a sample cut from a long section of the boring core, such as a two foot long sample, use the midpoint between the top and bottom of the length of the sample.

For instance, assume you drill two boring cores, each 2 feet long, and extending from 2 to 4 feet, and 4 to 6 feet. And assume that the entire length of each 2 foot core is sampled. Then, the sample depth entered into the calculator would be 4 feet. 4 feet is the midpoint between 2 (the sample top) and 6 (the bottom).

Stratum Range:

The stratum range (plural = strata) is the top and bottom depth (boundaries) of the stratum. The stratum ranges may not overlap, but they can use the same value as a boundary. The stratum range is entered as "top depth - bottom depth", with a hyphen in the middle.

For example, Enter range 1 as: 0 - 3 feet, range 2: 3 - 8 feet.

4.3.7.2 AUTO-DATA FEATURES:

Creates all screens (except background calculation) and enters all data. Using only the sample depth and stratum range, Auto-data calculates boring increment lengths for the weighted average calculation (a complicated calculation). However, neither the summary for boring or the subsurface soil inputs screen (save and calculate button), recalculates the increment length. To recalculate the increment length, the Excel input file, Quick Data, or EDD file must be changed and re - uploaded.

NOTE:

The Calculator does not use the sample depth or the stratum range to calculate any values.

4.3.7.3 BORING LOG EXAMPLES:

2 Strata, 2 Samples:

The geologic strata in a particular boring consists of a sand stratum and a silt stratum. The sand stratum extends from the surface to 4 feet below the surface. The silt stratum extends from 4 feet to 10 feet. One sample is taken from each stratum. The sand is sampled at a depth of 1 foot, and the silt is sampled at a depth of 8 feet.

In this case, the strata range for sand is 0 - 4 feet, and 4 - 10 feet for silt. The sample depth for sand is 1 foot and 8 feet for silt. The increment length is 4 feet for sand and is 6 feet for silt (since one increment length is assigned to each sample).

Multiple Samples within Stratum:

Assume the above scenario, except that 2 samples are taken within the silt stratum, one at 5 feet and the same sample at 8 feet.

In this case, the sand increment length stays the same, since increments may not cross a stratum border. But, within in the silt stratum, since there are two silt samples, there are two silt increments. The first increment extends from the stratum top, 4 feet, to the midpoint between the 5 foot and 8 foot sample depth, or 6.5 feet. The second increment extends from 6.5 feet to the bottom of the stratum, or 10 feet. So, the increment length for the first sample is 2.5 feet (4 - 6.5), and the increment length for the second is 3.5 feet (6.5 - 10).

- See the "Quick Data" Excel file in the Auto Data screen found in the screen layout for instruction on proper sample data entry.

4.3.8 Subsurface Soil Nature and Extent Summary: PEC METHODS

The site PEC is a evaluation of all location concentrations, and is a site wide concentration. In subsurface soil, the locations are simply the borings names. Site PECs are determined using one of the following two evaluations:

MAX WEIGHTED AVERAGE: Comparing all weighted averages within the site, the PEC is the highest of these weighted averages.

MAX INCREMENT AVERAGE: Comparing only the increment maximums within the site, the PEC is the highest of these increment maximums.

If the PEC is larger than the closure level (residential), the site is contaminated, if the PEC is smaller, the site is not contaminated.

4.3.8.1 BACKGROUND NATURE AND EXTENT –VS- BACKGROUND CLOSURE:

As previously stated, the nature and extent background evaluation also performs closure evaluation. Subsurface background closure is not performed in the closure evaluation screens. The subsurface nature and extent and subsurface closure evaluations are 2 separate evaluations performed on the same screen:

4.3.8.2 BACKGROUND NATURE AND EXTENT EVALUATION:

The nature and extent of contamination for background chemicals is determined by comparing each stratum/boring concentration to the background closure level. This is done in the summary for boring at stratum screen which displays all stratum location concentrations.

Within each boring, each stratum with concentrations above the background closure level are contaminated stratum locations. Using these location concentrations, the extent of contamination can be plotted on a site map by using one stratum layer for each stratum.

4.3.8.3 BACKGROUND CLOSURE PEC EVALUATION:

The background PEC is determined using one of the following methods.

MAX WEIGHTED AVERAGE: Comparing only the weighted averages within the stratum, the PEC is the highest of these weighted averages.

AVERAGE + 1 STANDARD DEVIATION: Using all weighted averages within the stratum, and only within the extent of contamination, the PEC is the average + 1 standard deviation of these averages.

- Only weighted averages within the previously defined extent of contamination may be used for the closure evaluation.
- Each stratum will have a PEC, and the extent of contamination is defined stratum by stratum within each boring. The "Stratum Result" column in the N&E summary screen shows average + standard deviation result for each stratum.
- Weighted averages below the detection limit should not be used as an input for the Ave + Std Dev method.

4.3.8.4 NUMBER OF SAMPLE LOCATIONS REQUIRED TO DEFINE NATURE AND EXTENT:

Two types of locations are needed, contaminated locations and uncontaminated locations (result of not contaminated). In the sampling procedure, sampling locations are chosen in four principal directions from the source (center) of contamination. As implied in the title, sampling continues in each of the four directions until an uncontaminated location is reached (until the "extent" is reached).

So, in all cases, a completed nature and extent soil evaluation requires the minimum number of locations above the closure level, and at least four locations below. Requirements are based on sample area size and are as follows:

4.3.8.5 AREA SIZE AND MINIMUM NO. LOCATIONS:

Area Size	**Number Contaminated Locations**	**Number Uncontaminated Locations**	**Minimum Total Locations**
0.5 acre or smaller	10	4	14
0.25 acre or smaller	5	4	9
0.1 acre or smaller	3	4	7

NOTES:

- The results shown on the Subsurface Soil Summary screen should include the minimum number of sample locations.
- The residential closure level or the background closure level is always used for nature and extent evaluations.
- Using the location concentration results, the extent of contamination can be easily defined and delineated on a site map.
- See the RISC Technical Guide, Chapter 4 for further instruction on nature and extent evaluation.
- Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

4.4 GROUNDWATER NATURE AND EXTENT (HYPERLINK)

The groundwater nature and extent evaluation operates identically to the surface soil nature and extent evaluation.

4.4.1 Screens and PEC Method

The groundwater nature and extent evaluation (hyperlink on Screen Layout) is performed by 3 screens:

Groundwater Nature and Extent Summary
.....Methods (1): Max Concentration
Groundwater Background Levels (closure levels)
.....Methods: None
Groundwater Nature and Extent Inputs.
.....Methods: None

4.4.2 Nature and Extent Summary:

This screen is both a summary and a calculation results screen, since no calculation equations are used, and since only one concentration is entered for each location (well), and this concentration is directly compared to the closure level.

The nature and extent summary shows the chemical sampled and tested, the closure level, the extent sampling locations and concentrations, and the site result (using the site PEC) in a table. The first row under the concentration boxes shows the sample location name or number.

Nature and extent does not have a Site Summary screen. Site summaries are shown on each media summary. The surface soil summary is also the site summary.

4.4.2.1 LOCATION AND PEC EVALUATION METHODS:

In nature and extent evaluations, each location is evaluated as well as the entire site. Each location concentration is compared to the residential closure level, and the PEC is compared to the residential closure level. For the site evaluation, the PEC is the highest concentration at the site.

Location Method: Each location concentration

If the location concentration is above the closure level, the location is contaminated, and if below, the location is not contaminated.

PEC Method: Maximum Concentration

If the PEC is above the closure level, the site is contaminated, and if below, the site is not contaminated. The Site Result column shows this result.

4.4.2.2 NON DEFAULT EVALUATIONS:

Non-default methods use the residential surface risk based closure level (RBL). In turn, the subsurface non-default nature and extent method also uses the RBL. See the View Closure Levels screen for RBL info.

4.4.3 Groundwater Background:

Press the Background button to enter the background chemical closure level. The groundwater background levels must be manually calculated, then entered. Load the background concentrations and press "Save and Calculate". Although there is no calculation executed, the background level is inserted as a closure level option in the N&E Inputs screen.

- After the background closure level is calculated, it is not used unless selected for use on the Inputs screen (see below).
- A background evaluation requires both a background closure level and background location concentrations (from contaminated zone).

4.4.4 Nature and Extent Inputs:

To enter sampling data, press the Add/Edit Data button to move to the nature and extent inputs screen. Locations and concentrations are entered here, and only one concentration may be entered for each sampling location. Notice that there is no choice for the evaluation method, since no calculation exists and the evaluation is always a closure level comparison.

Even if the background closure level is entered from the background level screen, it is not used unless selected for use on this screen. The closure level column provides two choices, background level(BG), or calculated level (CL). If background is chosen, it replaces the Calculator's calculated closure level. Consequently, the nature and extent evaluation now uses this background closure level. However, this background level must be chosen again in the closure evaluations. For non-detect concentrations, use the symbol "ND" in place of a number. Any number entered is assumed to be above the detection level. Only one concentration may be entered for each well.

NOTE: If the site result is "Not Contaminated", the nature and extent evaluation suffices as a closure demonstration.

4.4.4.1 RANDOM -VS- JUDGMENTAL SAMPLING:

None of the nature and extent evaluations use random sampling. Sampling locations are chosen by professional judgement.

4.4.4.2 NUMBER OF SAMPLE LOCATIONS REQUIRED TO DEFINE NATURE AND EXTENT:

A minimum of four (4) locations are needed, one in each prinicpal direction from the source (or suspected source). Two types of locations are needed, contaminated locations and uncontaminated locations (screen result of not contaminated).

In the sampling procedure, sampling locations are chosen in four principal directions (eg, north, south, east, west)from the source (center) of contamination. As implied in the title, sampling continues in each of the four directions until an uncontaminated location is reached (until the "extent" is reached).

In all cases, sampling results in any number of locations above the closure level, and at least four locations below. So, the summary screen should show at least four well locations below either the residential closure level or the background level.

NOTES:

- The residential closure level is always used as the closure level for nature and extent evaluations.
- Using the location concentration results, the extent of contamination can be defined and delineated on a site map.
- See the RISC Technical Guide, Chapter 4 for further instruction on nature and extent evaluation.
- Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

5 CLOSURE

5.1 OVERVIEW

As implied in the name, closure is the last step of the closure process. Closure may be achieved for an entire site, an entire media (surface or subsurface soil, or groundwater), or for a particular chemical within a media. However, until the entire site, all media and all chemicals, achieves closure, further action is required at the site. The closure evaluation is typically attempted after performing a nature and extent evaluation, and often after the related remediation activity.

5.1.1 Media Closure:

As in all three steps of the closure process, the closure evaluation may be conducted for only one, any two, or all three media: surface soil, subsurface soil, and/or groundwater.

5.1.2 PEC -vs- Closure

A Potential Exposure Concentration (PEC) is a chemical concentration representing the impact of one chemical within the entire site. For all media, surface soil/subsurface soil/groundwater, and for all evaluations, screening/nature & extent/closure:

> **If the PEC is below the closure level, the site is eligible for closure, for the chemical and media evaluated. If above, further action is required.**

5.1.3 Closure Evaluations

Closure evaluations are shown as hyperlinks of the screen layout. Closure evaluations and associated PEC methods are summarized as follows:

SURFACE SOIL:
.....Methods(2): Max Concentration & Upper Confidence Limit (UCL)

SUBSURFACE SOIL:
.....Methods (4): Max Weighted Average, UCL, Increment Average, & Increment Average + 1 Standard Deviation

GROUNDWATER:
.....Methods for All Sites (2): Closure Level Monitoring, and Stability Monitoring.

.....Methods for Petroleum Sites (3): Attenuation Modeling is added to above

5.1.4 Further Action -vs- Closure:

Further action means that closure is not allowed. Further action refers to activities which should be performed prior to attempting closure evaluation again. Typical options for further action are:

- Non-default risk assessment
- Re-sampling, or
- Remediation.

5.1.5 Default -vs- Non-Default Closure:

Except for one difference involving the closure level, the Calculator performs default and non-default closure evaluations in the same manner. The difference is that default surface and subsurface soil closure evaluations use the same closure level, the default level. Whereas, nondefault surface closure uses the surface risk-based level (RBL), and the subsurface soil evaluation uses the subsurface RBL. See the View Closure Levels screen which shows the RBLs and other closure level values.

5.1.6 Industrial -vs- Residential Closure:

Except for additivity, all closure evaluations are the same between these two options within the Calculator. The only difference, as is implied, is that the closure level for residential closure is the residential level, while industrial closure uses the industrial closure level.

5.1.7 Sampling Method: Random -vs- Judgmental Sampling:

Evaluations offering random sampling contain a screen which selects between random and judgmental sampling. Random sampling is an option in screening, surface soil only; and closure, surface and subsurface soil only.

The sampling area is always chosen using site knowledge and professional experience (professional judgment). After the sampling area is chosen, random sampling methods use an area grid and randomly select grid points as sampling locations. In judgmental sampling, the same sample area is used, but sample locations are selected using site knowledge and investigation experience (professional judgment).

- If locations are chosen using judgmental sampling, the random sampling evaluation methods may not be used.

5.1.8 Additivity & Closure:

All surface soil evaluations require an additivity evaluation. In groundwater closure, additivity is required when using the Closure Level Monitoring evaluation only. Stability monitoring and attenuation modeling do not use additivity evaluations.

The Calculator performs additivity evaluations automatically, and results are shown in an additivity screen within said evaluations.

5.1.9 Petroleum Sites:

Note that LUST program sites typically combine sampling for nature and extent and closure. However as for all sites, two evaluations, nature and extent and closure, are still needed.

For soil, nature and extent is performed on the nature and extent screens, while the subsurface closure evaluation uses the LUST Step-Out procedure. The step-out procedure is detailed in the Subsurface Closure for Boring screen notes, as well as the RISC User Guide, LUST Chapter.

For Groundwater, follow the same nature and extent and closure evaluations for all sites. The attanuation model is also available for petroleum groundwater closure.

5.2 SURFACE SOIL CLOSURE (HYPERLINK)

The surface soil nature and extent evaluation (hyperlink on Screen Layout) is performed by five (5) screens. Screens and PEC methods are shown below:

Surface Soil Closure Summary
.....Methods: None

Surface Soil Background Calculation
.....Methods (1): Average + Standard Deviation (a closure level)

Surface Soil Closure Inputs
.....Methods (2): Max Concentration, Upper Confidence Limit

Surface Soil Closure Results
.....Methods: None

Additivity:
.....Methods(2): Carcinogenic Ratio & Non carcinogenic Ratio Summations

5.2.1 Sampling Method: Random or Judgmental Sampling:

Choose the hyperlink within the summary table to change between random or judgmental sampling. The only difference between a judgmental and random evaluation, is that judgmental only compares each sample concentration, and random compares each sample concentration as well as the upper confidence level (UCL) of all sample concentrations. This is explained in Evaluations Methods below.

The sample area is always chosen judgmentally. Within the sample area, the sample locations are chosen either randomly or judgmentally.

- If locations are chosen using judgmental sampling, the random sampling evaluation methods may not be used.

5.2.2 Surface Soil Closure Summary

This screen shows all sample concentrations and results, including individual location results and site wide results. The closure summary shows the chemical sampled and tested, the closure level, the site PEC, and the site result, and the sampling locations and concentrations, in a table. The first row under the concentration boxes shows the sample location name or number.

This screen is almost identical to the surface soil nature and extent summary. The only difference is that this closure screen shows a closure PEC, since this PEC is determined using one of two methods. The nature and extent PEC is always the highest location concentration and the site PEC evaluation can be done by visual inspection.

As in all RISC Calculator evaluations, if the PEC is lower than the closure level, the site is eligible for closure. If the PEC is above the closure level, the site requires further action. The Site Result column shows this result.

Note that the closure level may be either the "calculated" closure level, or the "background" closure level. The calculated level means the level determined using the default RISC exposure equations found the View Closure Levels screen of the Calculator or in the RISC Technical Guide, Appendix 1.

5.2.3 Surface Soil Background:

A background concentration represents the chemical content of soil or groundwater near the site, but contains no chemical impact from the site. Background concentrations are typically naturally occurring. A background closure level may replace the calculated closure level for the Calculator's nature and extent or closure evaluations. Press the Background button to calculate a background chemical closure level. The background level calculated in this screen is the same level used in surface soil nature and extent evaluations. This screen requires sample locations and concentrations only. Load data and press Save and Calculate to produce a background (BG) level. The statistical calculation used is:

Background = Average concentration + 1 Standard deviation of samples.

- In surface soil, at least 4 samples are required for this calculation. Use 1/2 detection limit for non-detect concentrations.

5.2.4 Surface Soil Closure Inputs:

To enter sampling data, press the Add/Edit Data button to move to the Surface Soil Closure Inputs screen. Locations and concentrations are entered here, and only one concentration may be entered for each sampling location.

Notice that there is no choice for the evaluation method. Only two evaluation methods exist, the maximum sample concentration (a PEC), and the UCL (a PEC). The Calculator assigns the method(s) used based on the earlier selection of judgmental or random sampling.

5.2.4.1 SAMPLE LOCATION:

Closure samples should be located within the extent of contamination. So, the same locations sampled in the nature and extent evaluation may be used in the closure evaluation screen. Note that a closure evaluation is also performed in the nature and extent evaluation, but the only PEC method used is the maximum concentration.

- For nondetect concentrations, use the symbol "ND" in place of a number. Any number entered is assumed to be above the detection level.

5.2.4.2 BACKGROUND CLOSURE LEVEL:

Once the background closure level is calculated, it is not used unless selected for use on this screen. The closure level column provides two choices, background level(BG), or default level (DL). If background is chosen, it replaces the Calculator's calculated closure level. This same background level is also stored and available for the nature and extent evaluation, but is not activated until selected in the nature and extent evaluations.

5.2.5 Closure Results: PEC Evaluation Methods

Two PEC evaluation methods are used in surface soil closure:

MAXIMUM CONCENTRATION, for Judgmental or Random Sampling:

The PEC is the highest location concentration from all samples entered on this screen. As the name implies, this method is the same as the surface soil screening maximum concentration PEC method. Any set of randomly sampled concentrations may be evaluated with this method also.

UPPER CONFIDENCE LIMIT, (UCL) For Random Sampling only:

The PEC is the statistical upper confidence limit of sample concentrations within the extent of contamination. Non-detect concentrations are not used in the calculation.

In all PEC evaluations, the PEC is compared to the closure level. If the PEC is larger than the closure level, further action is required, and if smaller, the site is eligible for closure.

Background Chemicals:

The PEC evaluation methods for background chemicals are the same, the maximum concentration for judgmental or random sampling, and the UCL for random sample concentrations.

5.2.5.1 CLOSURE SITE SUMMARIES:

Results from all evaluations are displayed in the Closure Site Summary screen. Unless this screen shows an "Eligible for Closure" result, site closure should not be attempted for any chemical evaluated.

5.2.5.2 SELECTION OF AND NUMBER OF SAMPLE LOCATIONS REQUIRED FOR CLOSURE DEMONSTRATIONS:

Sample locations for closure demonstrations should be selected within the extent of contamination. Unless the extent of contamination is determined, closure demonstrations should not be attempted within the Calculator.

The results shown on the Surface Soil Summary screen should include the required number of sample locations and concentrations. Requirements are based on sample area size and are as follows:

AREA SIZE AND MINIMUM NO. LOCATIONS:

Area Size	**Minimum Number of Locations**
0.5 acre or smaller	10
0.25 acre or smaller	5
0.1 acre or smaller	3

5.2.6 Additivity:

Pressing "Additivity" from the Summary screen shows this additivity screen. Carcinogenic and non-carcinogenic additivity results are displayed here. The evaluations are automatically performed by the Calculator.

ADDITIVITY EVALUATION AND PEC:

In surface soil, all chemicals, except background chemicals, are required to evaluate additivity. Additivity is performed after the PECs are calculated. The additivity evaluation is performed automatically by the Calculator using the same basic method for carcinogens and for non-carcinogens. Method is as follows:

PEC / CLOSURE LEVEL RATIO SUM:

Ratio Sum = (PEC1/CL1 + PEC2/CL2 + ... PECn/CLn)

Where n is the number of chemicals having the same carcinogenic or critical effect. The additivity table shows 10 critical effects and one carcinogenic effect.

CL = closure level
PEC = potential exposure concentration
Ratio = PEC/CL

If the sum is greater than 1, further action is required. If the sum is less than 1, the site is eligible for closure.

- For Background Chemicals: Additivity is not performed.

SURFACE CLOSURE NOTES:

- See the RISC Technical Guide, Chapter 6 for further instruction on closure evaluation.
- Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

5.3 SUBSURFACE SOIL CLOSURE (HYPERLINK)

This evaluation determines whether the subsurface soil requires further action or whether the site is eligible for closure. Further action means either further sampling and assessment, a nondefault assessment, or remediation. The Calculator can be used for either further assessments or certain non-default assessments.

In this evaluation, the Calculator determines a boring concentration representing all sample concentrations within the boring. Then using this set of boring concentrations, determines a site concentration, the site PEC, representing all boring concentrations within the site. The PEC is then compared to the closure level to determine further action or closure.

As in all evaluations, if the PEC is below the Closure Level, the site is eligible for closure, for the particular chemical and media evaluated.

5.3.1 Site Summary:

The subsurface closure site results, showing whether the site (not just the boring) is eligible for closure or requires further action, are shown only on the Closure Site Summary screen, and are not shown on this screen. The PEC -vs- closure level comparison is made in this summary, and not within the individual media evaluations (surf/Subsurf/GW), including this subsurface evaluation. In contrast, the subsurface nature and extent site results are shown in the subsurface N&E summary.

5.3.2 Background:

Background chemicals are evaluated stratum by stratum, and a site wide PEC is calculated for each stratum. A simple way to imagine the background site evaluation is to view each stratum as a separate site. For instance, if one site has three strata (plural of stratum), the Calculator acts as if three sites are stacked on top of each other, one site for each stratum. Subsurface background is described in more detail in the Background PEC Methods discussion.

5.3.3 Auto-Data Upload:

Except for background nature and extent chemicals, all closure and nature & extent sampling data can be electronically entered using the Quick Data Excel file and the auto data function. Closure data can be directly loaded via auto-data, however nature and extent data must be electronically entered into closure via auto-data, then "imported" into nature and extent using the "import data from closure" buttons within the nature and extent screens.

5.3.4 Screens and Evaluations

As stated above, the subsurface evaluation starts with assigning borings, sampling borings, determining a boring concentration, and determining a site concentration (the PEC). The PEC is then compared to the closure level. This evaluation contains four (5) screens. Screens and Evaluation Methods are summarized below:

Choose Judgmental or Random Sampling:
.....Judgmental PEC Methods: Max Weighted Average/Increment Aves
.....Random PEC Methods: Same as judgmental, but adds UCL

Add/Edit Subsurface Soil Borings:
.....No Method

Subsurface Summary for Boring & Subsurface Inputs for Boring:
.....Methods: Weighted Average OR Increment Max

Suburface Closure Results:
.....PEC Methods: Max Weighted Average OR Increment Average

5.3.5 Sampling Method: Random or Judgmental Sampling:

Choose between random or judgmental sampling on this screen. The only difference between a judgmental and random evaluation, is that judgmental only compares each boring concentration, and random compares each boring concentration as well as the upper confidence level (UCL) of all boring concentrations. For more details, see Summary for Boring and PEC Evaluations below.

The sample area is always chosen judgmentally. Within the sample area, the sample locations are chosen either randomly or judgmentally.

- If locations are chosen using judgmental sampling, the random sampling evaluation methods may not be used.

5.3.6 Add/Edit Subsurface Soil Borings:

This screen creates boring names and changes boring names. The RISC Calculator does not use random sampling for subsurface nature and extent evaluations. All boring locations are chosen using professional judgement. The "Save Edits" button returns to this same screen and is used when a large number of borings are evaluated. The Accept Boring Names button saves the boring names, then displays the nature and extent summary screen.

5.3.7 Summary for Boring (boring name):

This screen determines a boring concentration representing all sample concentrations within the boring.

The boxes in the Method and the Result or PEC columns of the Summary table have a number of different meanings. The result may be an individual boring concentration, or the result may be a site-wide concentration (a PEC), averaged across all borings. The methods and results are also based on whether random or judgmental sampling was used to choose boring locations.

5.3.7.1 IF USING JUDGMENTAL SAMPLING:

For a "Weighted Average " method, the Result or PEC box will show a boring result representing the weighted average concentration of all samples within each individual boring. In addition, a "*" will appear on the boring result with the highest concentration among all borings. The result with the "*" is the site-wide PEC concentration, and is located at this boring.

For "Increment Average" methods, the Result or PEC box will show a site PEC result that represents the increment average (concentration) for all borings at the site. So, the same number will appear in the result box since the result is an average of boring concentations across the site. There are two increment average methods, increment average and increment average + 1 standard deviation.

5.3.7.2 IF USING RANDOM SAMPLING:

The 95% UCL method, for weighted averages only, is added to the method list. The 95%UCL concentration of the boring weighted averages across the site is shown in the result box, and is a site PEC.

For a "Weighted Average" method, or for the "Increment Average" methods, the results are identical to the judgmental sampling results.

5.3.7.3 BORING METHODS AND CONCENTRATIONS

The Calculator determines a boring concentration automatically based on the random/judgmental discussion above, and the sampling methods and evaluations described below:

For a single boring, there are basically two boring sampling methods "Methods column", and two associated method results "Result column". The PEC methods, including background PECs, use one of the two boring methods below:

WEIGHTED AVERAGE (includes background): The result, a concentration, from all lab-analyzed samples within a boring*. The weighted average also applies to background evaluations.

INCREMENT MAXIMUM: The lab-analyzed result, a concentration, from the boring's field sample increment having the highest field reading.** The increment max does not apply to background. Only one lab result is required from each boring.

*In the weighted average method, all samples within the boring are sent to the lab, and all lab sample concentration results are entered into the Subsurface Closure Inputs screen (Add/Edit button). The weighted average of these concentrations is:

Weighted Average = Sum of (increment lengths x increment concentrations) / Sum of (increment lengths).

- Non-detect concentrations are not evaluated in the weighted average method, but may be entered (as "ND").

** The Volatile Field Screening sampling procedure must be used when determining the increment maximum. In this method, each boring sampling increment is field screened (eg, a PID instrument). The increment sample having the highest field reading (increment maximum) is sent to the lab. This lab concentration is entered as the boring concentration. The Calculator's increment average method will accept more than one concentration entered for each boring, but will select the highest concentration entered as the boring concentration.

See the Subsurface Screening Clarification at:
http://www.in.gov/idem/land/risc/techguide/index.html

Method Selection:

As in all subsurface evaluations, screening, nature and extent, and closure, the method selection is done on the first boring entered for the site. All other borings at the site use the same method for a particular chemical. Note that each chemical may use a different boring evaluation method.

5.3.8 Subsurface Closure Inputs for (boring name):

To enter sampling data, press the Add/Edit Data button on the summary for boring to move to the nature and extent inputs screen. Locations and concentrations are entered here, and only one concentration may be entered for each sampling location (within the boring). Notice that there is no choice for the evaluation method, which was selected on the boring summary screen.

5.3.8.1 BORING LOG INPUTS

Of the three boring log parameters, increment length/sample depth/stratum range, only the increment length is used in the weighted average calculation. Sample depth and stratum range are used in the increment length calculation executed by the auto data process, but not for the weighted average calculation. These two are provided on this screen for information purposes only. Definitions and descriptions are discussed below:

Increment length:

The increment length is the length of the boring represented by one sample. Increment lengths are not determined until sampling of the boring is completed. The top of the top increment in the boring is always the surface. The bottom of each increment length is either the midpoint between the increment's sample depth and the following increment's sample depth, or the bottom of the stratum containing the increment's sample.

- An increment cannot cross a stratum boundary.
- Only one increment is allowed for each sample. The number of increments = the number of samples.
- The sum of the increment lengths within one stratum = the stratum length.

Sample Depth:

The sample depth is the depth that the sample was collected during field sampling. For a sample cut from a long section of the boring core, such as a two foot long sample, use the midpoint between the top and bottom of the length of the sample.

For instance, assume you drill two boring cores, each 2 feet long, and extending from 2 to 4 feet, and 4 to 6 feet. And assume that the entire length of each 2 foot core is sampled. Then, the sample depth entered into the calculator would be 4 feet. 4 feet is the midpoint between 2 (the sample top) and 6 (the bottom).

Stratum Range:

The stratum range (plural = strata) is the top and bottom depth (boundaries) of the stratum. The stratum ranges may not overlap, but they can use the same value as a boundary. The stratum range is entered as "top depth - bottom depth", with a hyphen in the middle.

For example, Enter range 1 as: 0 - 3 feet, range 2: 3 - 8 feet.

- The Calculator does not use the sample depth or the stratum range to calculate any values.

Auto-Data Increment Length:

Creates all screens (except background) and enters all data. Using only the sample depth and stratum range, Auto-data calculates boring increment lengths for the weighted average calculation (not a trivial calculation). However, neither the Summary for Boring B1 or the Subsurface Soil Inputs screen (save and calculate button), re-calculates the increment length. To re-calculate the increment length, the Excel input file, Quick Data, or EDD file must be changed and re-uploaded. (note that the increment length calculation is not a trivial calculation.)

5.3.8.2 BORING LOG EXAMPLES

2 Strata, 2 Samples:

The geologic strata in a particular boring consists of a sand stratum and a silt stratum. The sand stratum extends from the surface to 4 feet below the surface. The silt stratum extends from 4 feet to 10 feet. One sample is taken from each stratum. The sand is sampled at a depth of 1 foot, and the silt is sampled at a depth of 8 feet.

In this case, the strata range for sand is 0 - 4 feet, and 4 - 10 feet for silt. The sample depth for sand is 1 foot and 8 feet for silt. The increment length is 4 feet for sand and is 6 feet for silt (since one increment length is assigned to each sample).

Multiple Samples within Stratum:

Assume the above scenario, except that 2 samples are taken within the silt stratum, one at 5 feet and the same sample at 8 feet.

In this case, the sand increment length stays the same, since increments may not cross a stratum border. But, within in the silt stratum, since there are two silt samples, there are two silt increments. The first increment extends from the stratum top, 4 feet, to the midpoint between the 5 foot and 8 foot sample depth, or 6.5 feet. The second increment extends from 6.5 feet to the bottom of the stratum, or 10 feet. So, the increment length for the first sample is 2.5 feet (4 - 6.5), and the increment length for the second is 3.5 feet (6.5 - 10).

See the "Quick Data" Excel file in the Auto Data screen found in the screen layout for instruction on proper sample data entry.

5.3.8.3 PEC EVALUATIONS (SITE-WIDE EVALUATIONS):

The site PEC is a evaluation of all location concentrations, hence an evaluation of the entire site. In subsurface soil, the locations are simply the borings names. Site PECs and methods are listed below:

1) MAX WEIGHTED AVERAGE: Determine the weighted averages from all borings within the extent of contamination. The PEC is the maximum of these boring weighted averages.

- All chemicals may use the max weighted average PEC method.

2) UPPER CONFIDENCE LIMIT(UCL) Random Sampling Only: Determine the weighted average from all borings within the extent of contamination. Assuming the boring locations were determined randomly, the PEC is the upper confidence limit (t - test) of these weighted averages.

- All chemicals may use the upper confidence limit.

3) INCREMENT AVERAGE (Volatile Chemicals only): Select the 3 highest increment maximums out of all borings within the extent of contamination. The Increment Average is the average of these 3 maximums.

- Only volatile chemicals may use the increment average method. The Calculator automatically offers this method for designated chemicals.

4) STEP-OUT PROCEDURE, Increment Average + Standard Deviation method: Using the Step - Out sampling procedure*, determine the restricted set of increment maximums**. The PEC is the average + 1 standard deviation of the restricted maximums.

Although petroleum sites may attain closure using only one sampling event, two evaluations are required: a nature and extent evaluation and a closure evaluation. So, petroleum sites should complete both the nature and extent subsurface and the closure subsurface screens to demonstrate closure.

> **The step-out closure evaluation should only be attempted after completing the step-out subsurface nature and extent demonstration.**
>
> Only the LUST program petroleum chemicals may use this method. The Calculator automatically offers this method for volatiles and the seven petroleum PAHs.
> This method is also used for nature and extent background evaluations (average + 1 standard deviation), but this particular evaluation is not a background evaluation.

* Step - Out Procedure: (RISC User Guide LUST Chapter):

LUST petroleum sites are typically closed using the step - out procedure. This procedure uses the same Volatile Field Screening sampling procedure (See Boring Sampling Methods above) for volatile chemicals at each sample location, in which the sample having the highest field instrument reading (increment maximum) is sent to the lab. The lab result is the boring concentration (increment maximum).

Subsurface Nature and Extent Evaluation:

In each of 4 principal directions (ie, north, south, east, west of source), sampling extends from the source (steps out) until a boring concentration (increment maximum) is found below the residential closure level. Such sampling produces an unlimited number of boring concentrations above the residential level, and at least four (4) boring concentrations below the residential level.

- The subsurface nature and extent evaluation screens should be used for this demonstration.

****** Restricted Boring Concentrations (Increment Maximums):

The restricted set of inputs to the Increment Average + Standard Deviation PEC Calculation are taken from the pool of all boring concentrations (increment maximums) as follows:

-From all of the boring concentrations above the residential closure level: use all as inputs, AND

- From all of the boring concentrations below the residential closure level: use four (4) inputs, by choosing AT MOST ONE boring concentration in each of the four directions from the source. Typically, choose the boring concentration closest to the source.

Step-Out Procedure Notes:

- Restricting the pool of boring concentrations is needed to avoid dilution of the average. Adding an unrestricted set of low boring concentrations biases the average on the low side.
- (See also RISC User Guide LUST Chapter): http://www.in.gov/idem/land/risc

PEC Method Notes:

The subsurface background closure evaluation is performed within the nature and extent evaluation screens. Results are transferred to the closure site summary.

5.3.8.4 SELECTION OF AND NUMBER OF SAMPLE LOCATIONS REQUIRED FOR CLOSURE DEMONSTRATIONS:

Sample locations for closure demonstrations should be selected within the extent of contamination (as determined in N&E step). Unless the extent of contamination is determined, closure demonstrations should not be attempted within the Calculator.

Requirements are based on sample area size and are as follows:

AREA SIZE AND MINIMUM NO. LOCATIONS:

Area Size	**Minimum Number of Locations**
0.5 acre or smaller	10
0.25 acre or smaller	5
0.1 acre or smaller	3

SUBSURFACE CLOSURE NOTES:

- In subsurface soil, a boring is a sample location. So, for 0.5 acre sites, 10 borings are selected from within the extent of contamination.
- Randomly selected boring locations should be selected from within the extent of contamination. See the RISC Technical Guide, Chapter 6 for further instruction on closure evaluation.
- Web-site: http://www.in.gov/idem/land/risc/techguide/index.html

6 GROUNDWATER CLOSURE (Hyperlink)

6.1 OVERVIEW:

Groundwater closure (hyperlink from screen layout) offers two monitoring evaluations for all sites, Closure Level Monitoring and Stability Monitoring. A third option is available for petroleum sites, Attenuation Modeling. Closure level monitoring requires two years of monitoring, while stability monitoring requires 7 years of monitoring. Attenuation modeling closure can be performed in as little as three years.

6.1.1 Groundwater Closure Methods Summary:

Monitoring options and evaluation methods are listed below:

Closure Level Monitoring:
.....Methods: Maximum concentration or Maximum average concentration.

Stability Monitoring:
.....Methods: Mann-Kendall trend test and Wilcoxon detection monitoring test.

Attenuation Modeling:
.....Methods: First order decay model and Mean square error.

6.1.1.1 PEC -VS- LONG TERM MONITORING:

Of the three options, only closure level monitoring uses a PEC. Stability monitoring and attenuation modeling use long term monitoring results and statistical calculations in place of a PEC.

> **For closure level monitoring, if the PEC is lower than the closure level, the site is eligible for closure. If the PEC is above the closure level, the site requires further action.**

6.1.1.2 FURTHER ACTION -VS- CLOSURE:

Further action means that closure is not allowed. Further action for groundwater closure may mean continued monitoring within the same monitoring option, switching the closure monitoring option, performing remediation, or using the same data and a non-default assessment method to explain plume behavior.

6.1.1.3 SWITCHING MONITORING OPTIONS (GROUNDWATER CLOSURE TYPE SCREEN):

Monitoring options may be switched at any time during the evaluation. Also, if data is entered for one option, the same data will be available for either of the other two options. For example, if 8 quarters of data, with 5 chemicals, are entered for closure level monitoring, and if the option is changed to stability monitoring, then the 8 quarters and 5 chemicals will be inserted into the stability monitoring screens. So, the stability monitoring evaluation can be performed without having to re enter data.

6.1.1.4 INDUSTRIAL -VS- RESIDENTIAL CLOSURE CRITERIA:

Industrial closure can be demonstrated by using any of the three options, closure level monitoring, stability monitoring, or attenuation modeling. Residential closure demonstrations will typically use only closure level monitoring, since stability monitoring and attenuation modeling apply only if the plume concentrations are above residential levels.

RISC requires that the residential closure level boundary must be either stable or shrinking for a plume to eligible for closure. This applies to all plumes, whether the site is "residential" or "industrial". The calculator can be used to make this demonstration using either the closure level monitoring, the detection monitoring, or the stability monitoring option, or any combination of the three.

So, "Industrial" groundwater closure demonstrations should contain two closure demonstrations, an industrial closure evaluation, and a residential closure demonstration for the residential boundary of the plume. Note that two separate Calculations can be submitted to meet these requirements (one industrial and one residential).

6.1.1.5 ADDITIVITY:

Only Closure Level Monitoring evaluations require an additivity evaluation to reach closure. If closure level monitoring is used, then:

For Residential Sites: Additivity is performed only for chemicals without a maximum contaminant level (MCL). Chemicals having an MCL are not evaluated for additivity.

For Industrial Sites: Additivity is performed for all chemicals.
For Background Chemicals: Additivity is not performed.

6.1.2 Closure Method Options:

Pressing Groundwater, under Closure from the screen layout, shows this screen. Here, the monitoring wells are named, and one of the three monitoring options are selected, closure level monitoring, stability monitoring, or (for petroleum only) attenuation modeling.

6.2 CLOSURE LEVEL MONITORING:

Closure level monitoring is typically used to close plumes which have relatively low levels of contamination. This option requires 8 quarters of monitoring data (2 years), and can be used for any chemical.

6.2.1 Screens and Methods:

The closure level monitoring screens:

- Groundwater Closure Results Summary (well #)
- Groundwater Closure Inputs for (well#)
- Groundwater Closure Results for (well #)

.....Methods: Max Concentration & Upper Confidence Limit

- Add Monitoring Wells
- Groundwater Background Levels
- Additivity for Groundwater

.....Methods: Max Concentration and Max Average

- Groundwater Closure Results Summary, (for all wells)

6.2.2 Groundwater Closure Results Summary for (well#):

This screen shows the chemical, the inputs, the closure level and type, the PEC, and the site result. Only monitoring well M1 is summarized here. The other wells can be seen using the "select monitoring well" pulldown. All other screens for this well are selected here. The "Result" column is a site result and displays whether the site may close for a particular chemical.

6.2.2.1 SWITCHING GROUNDWATER CLOSURE METHODS (OPTIONS): (HYPERLINK)

See Switching Monitoring Options above. Changing monitoring options retains sampling data, but calculation results and PECs will need to be executed again.

6.2.3 Add Monitoring Wells(Change Well Evaluation):

Background and sentinel wells are not evaluated in closure level monitoring. However, to evaluate data from the background or sentinel wells using the closure level monitoring method, change the monitoring well type from "background or sentinel" to "stability or closure level" using this screen. To change the well type, input the well name in the "Monitoring Well Name" box, and select the well type from the three choices.

6.2.4 Groundwater Background:

Press the Background button to enter the background chemical closure level. The groundwater background levels must be manually calculated, then entered. Load the background concentrations and press "Save and Calculate". Although there is no calculation executed, the background level is inserted as a closure level option in the N&E Inputs screen.

- Use 1/2 detection limit for non-detect concentrations.

6.2.5 Groundwater Inputs for (well#):

To enter sampling data, press the Add/Edit Data button to move to the groundwater inputs screen. Concentrations from eight quarters for one well are entered here, and only one concentration may be entered for each sampling quarter.

- For non-detect concentrations, use the symbol "ND" in place of a number.
- Any number entered is assumed to be above the detection level.
- Only one concentration may be entered for each well.

SELECT BACKGROUND CLOSURE LEVEL:

Even if the background closure level is entered from the background level screen, it is not used unless selected for use on this screen. The closure level column provides two choices, background level(BG), or calculated level (CL). If background (BG) is chosen, the closure evaluation uses the BG level, however, no other Calculator evaluation, will use this BG level unless it is selected within each evaluation.

6.2.6 Results for (well#) and PEC Evaluation Methods:

Evaluation results of the sample data are shown here. The "Result" column is a site wide evaluation using the PEC. As in the surface soil closure evaluations, the evaluation methods are automatically performed. Two site wide PECs are used for each eight quarters of data using the following methods:

MAX CONCENTRATION: For each chemical, the maximum concentration from the eight quarters is the PEC.

UPPER CONFIDENCE LIMIT (UCL): For each chemical, and using the eight concentrations, the UCL, a statistical calculation using the t-test, is the PEC.

The Calculator performs both evaluation for each chemical, first the maximum concentration, and upon failing, the UCL. If either of these evaluations reaches closure, the site may close for the chemical evaluated.

6.2.6.1 NUMBER OF WELLS AND SAMPLES REQUIRED FOR CLOSURE:

Closure level monitoring requires at least one well. If using only one well, this well should be placed in the most highly concentrated location of the plume.

Each well using the Closure Level Monitoring PEC requires at least 8 consecutive quarters of data to reach closure.

- The same data used in stability monitoring may be used at any time. For example, assume that you perform stability monitoring for 4 years, and generate 16 quarters of data for the wells with the highest concentrations. You may use any 8 consecutive quarters of this data to attempt closure using closure level monitoring.

6.2.7 Additivity:

Pressing "Additivity" from the Summary for (well #) screen shows this screen. Carcinogenic and non-carcinogenic additivity results are displayed here. The evaluations are automatically performed by the Calculator.

6.2.7.1 ADDITIVITY EVALUATION AND PEC:

The additivity PEC is determined using one of two methods:

MAX CONCENTRATION: As used in many other evaluations. The Calculator chooses the maximum concentration from the eight quarters of data in each well. Then chooses the PEC as the maximum from these maximums, which is also the maximum concentration result for the site. OR,

MAX AVERAGE (Mean): For each well, the Calculator calculates the average (mean) of the eight quarters of data. Then chooses the PEC as the maximum from these maximums. The PEC is shown in the PEC (Mean) box on this screen. (The term "Mean" was used to save space in the box.)

6.2.7.2 ADDITIVITY LIMITATIONS:

For Residential Sites: Additivity is performed only for chemicals without a maximum contaminant level (MCL). Chemicals having an MCL are not evaluated for additivity.

For Industrial Sites: Additivity is performed for all chemicals.

For Background Chemicals: Additivity is not performed.

NOTE: See the RISC Technical Guide, Chapter 6 and Appendix 1 for further instruction on groundwater closure level monitoring evaluation.

Web-site: http://www.in.gov/idem/land/risc/techguide/index.html